

# Lecture 27: Privacy

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CS 5430

5/7/2018



Confidentiality

Integrity

Availability

# Privacy

*Privacy* concerns information about individuals (people, organizations, etc.)

- Often construed as legal right
- *Privacy* is not a synonym for confidentiality or for secrecy

# What is Privacy?



# What is a privacy violation?

- Police read papers stored in your home
- Police read papers you threw in the trash
- Police read your medical records
- Your parents read your medical records
- Gannett uses your medical records in a research study
- Police read your texts/Facebook messages
- Police read your emails
- Google employee reads your emails
- Google uses your emails to target personalized ads
- Someone tracks your location for months (using phone)

# Privacy in American Law



# Contextual Integrity



- defines privacy relative to appropriate context
- considers information type, time, location, purpose, principals involved (subject, sender, receiver)
- dependent on social norms
- norms can change over time



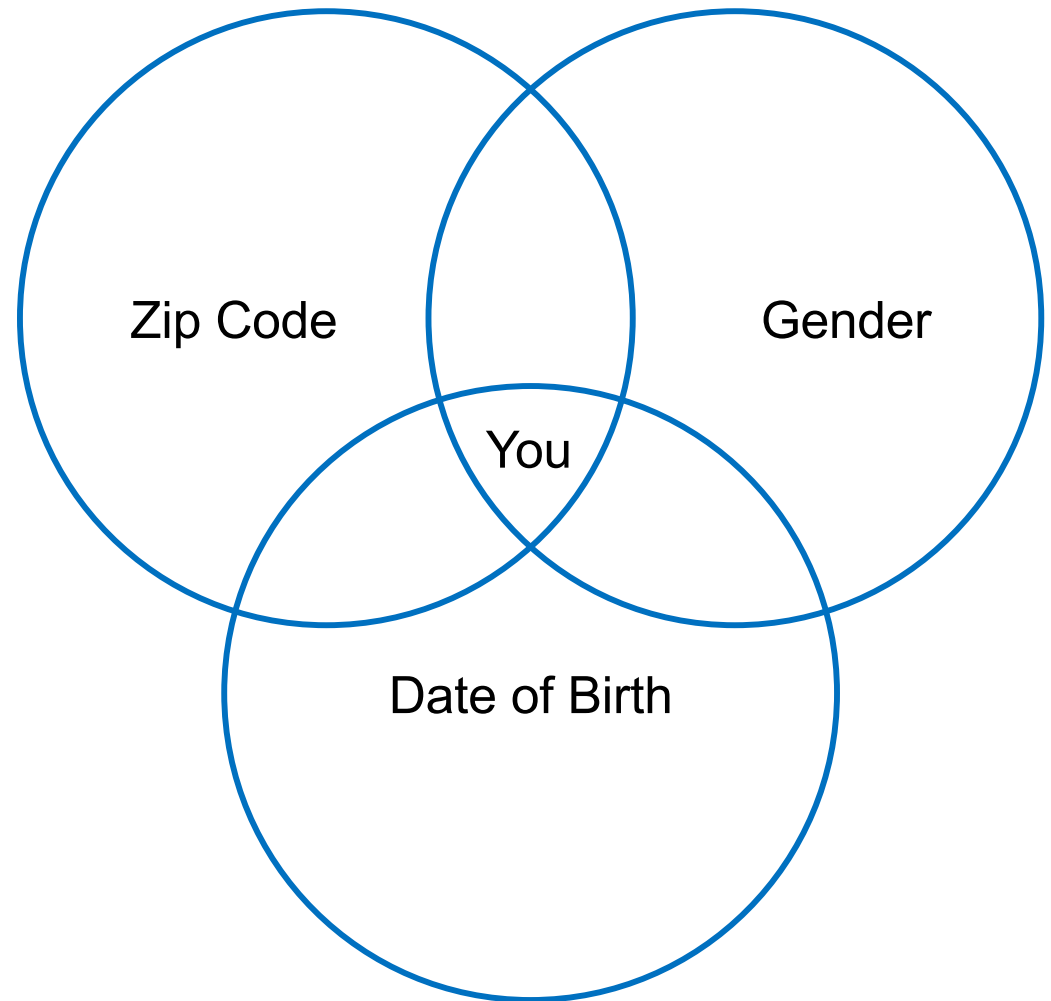
# General Guidelines

The FTC's Fair Information Practice Principals (FIPPs) are the most broadly recognized guidelines for handling private data in information systems

- Seek consent
- Minimize data use
- Limit storage
- Avoid linking



# Deanononymization



# Deanononymization

AOL®



# Deanonymization

The image shows the word "NETFLIX" in a bold, white, sans-serif font with a black drop shadow, centered on a solid red rectangular background. The letters are slightly shadowed to give a 3D effect.

**NETFLIX**

# k-Anonymity

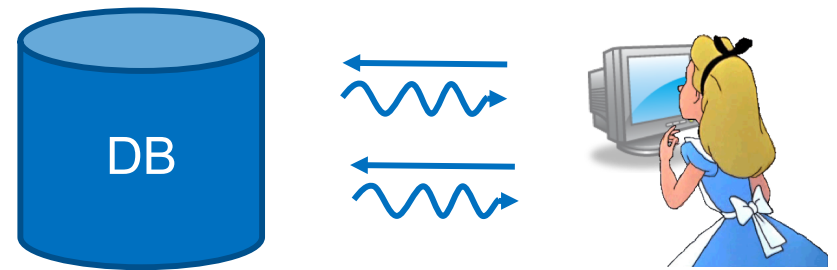
Name	Gender	Year	Grade
Alice	F	2018	95
Bob	M	2018	80
Charlie	M	2018	95
David	M	2018	60
Edward	M	2019	80
Flora	F	2019	99
Georgia	F	2019	60

# Database Privacy

## Offline Privacy



## Online Privacy



# Data Perturbation

Method	Accuracy	Time	Memory
Random	0.75	1.0	1.0
Dropout	0.78	1.0	1.0
DropConnect	0.79	1.0	1.0
DropBlock	0.80	1.0	1.0
DropPath	0.81	1.0	1.0
DropLayer	0.82	1.0	1.0
DropNode	0.83	1.0	1.0
DropEdge	0.84	1.0	1.0

# Differential Privacy

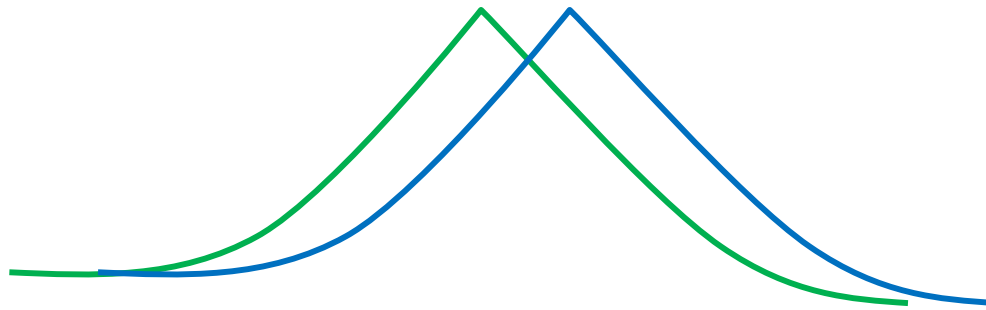


- absolute privacy is impossible
- goal should be to limit how much information can be learned
- A query  $Q$  is  $\epsilon$ -differentially private if  $\forall D, r \in D$ ,  
$$\Pr[Q(D) = x] \leq e^\epsilon \cdot \Pr[Q(D - r) = x]$$

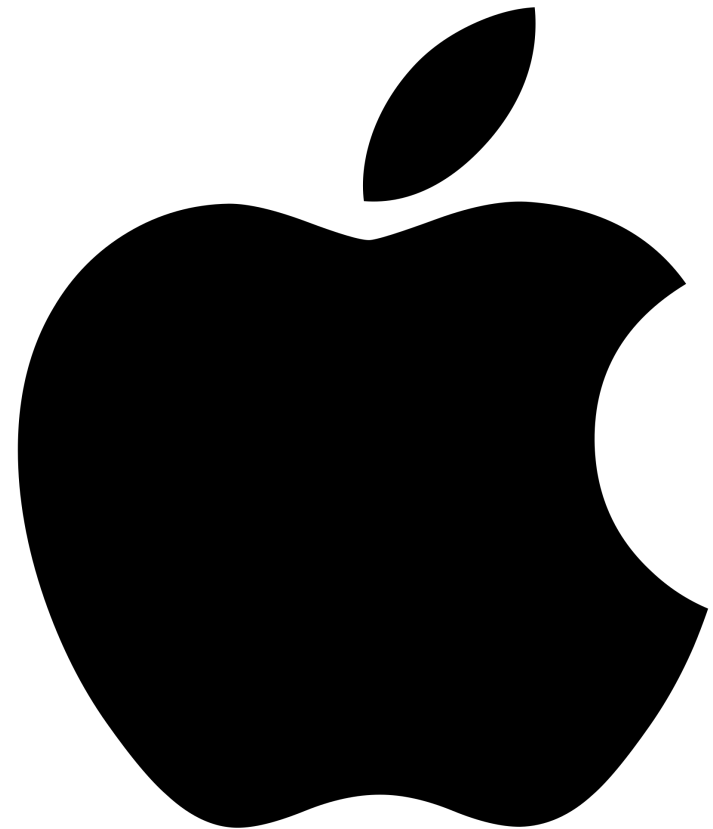
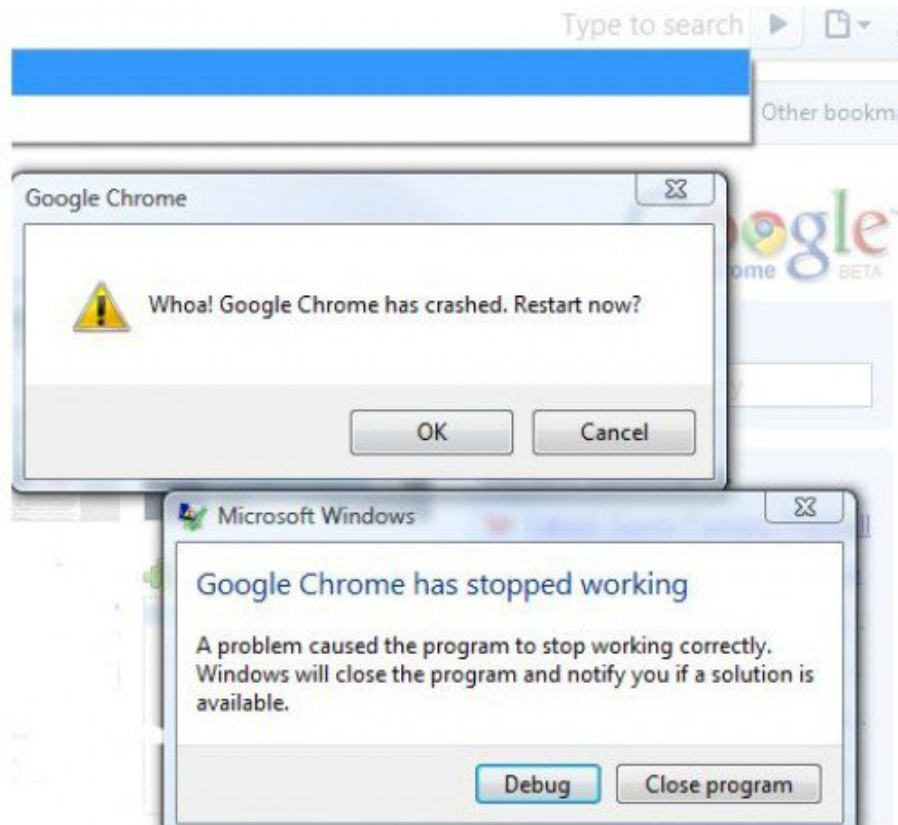


# Differential Privacy

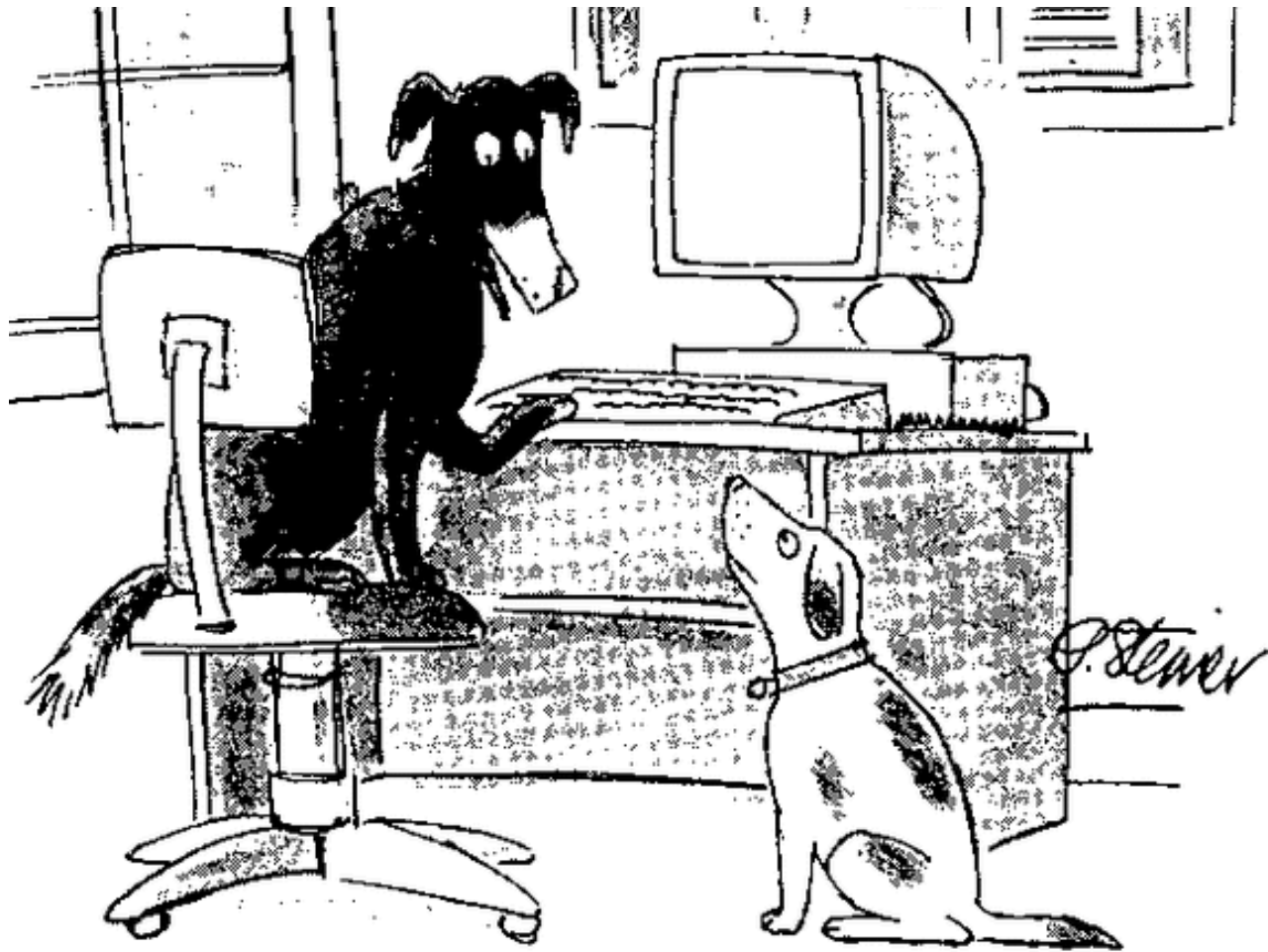
Key Idea: Changing a single user's record does not significantly affect the result of any analysis or query



# DP in action...



# Internet Privacy



*"On the Internet, nobody knows you're a dog."*

# Internet Privacy

The Joy of Tech™



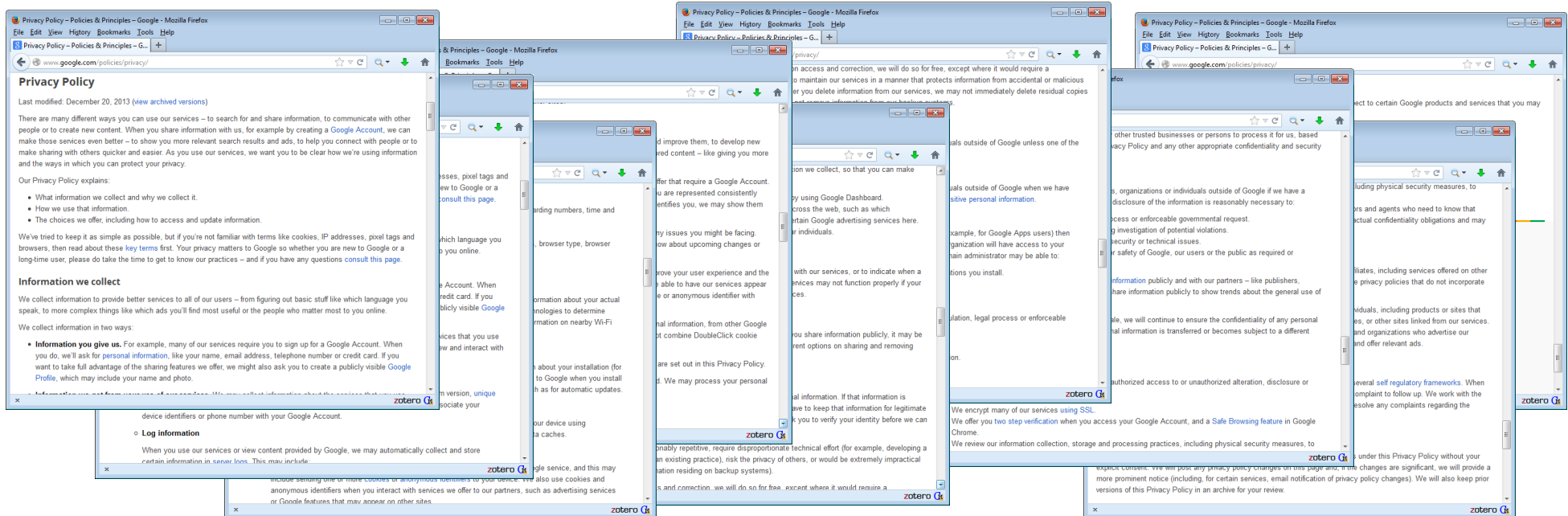
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by Nitrozac & Snaggy



joyoftech.com

# Notice & Consent





# Browser Tracking



DATA CENTER

SOFTWARE

SECURITY

TRANSFORMATION

DEVOPS

BUSINESS

PERSONAL TECH

SCIENCE

EMERGENT TECH

BOOTNOTES



## Personal Tech

### US Senate votes to let broadband ISPs sell your browser histories

Hear that? That's the sound of ringing tills, sorry, freedom



23 Mar 2017 at 19:23, Kieren McCarthy



#### More like this

FCC

Isps

Congress

Privacy



阿里云国际站正式上线

美国、香港、新加坡、中国等全球覆盖. 全球统一账号, 体

# Browser Tracking





# Browser Tracking

The image shows a screenshot of the New York Times website. At the top, there is a navigation bar with 'SECTIONS', 'SEARCH', and 'SUPPORT NOW' buttons. The main header features the 'The New York Times' logo and the date 'Thursday, March 23, 2017'. A large banner advertisement for pet food is visible, with the text 'When you buy any bag of dog or cat food, we give a meal to a pet in need.' Below the banner, a browser developer tools window is open, displaying the 'All Resources' tab. The table below lists various resources loaded by the browser, including JavaScript files from YouTube, Akamai, Doubleclick, and Twitter, as well as a CSS file from Innovid and a beacon from Krxd.

Name	Domain	Met...	Sch...	Status	Cac...	Size	Transfer...	Start Time	Latency	Duration
blob:https://www.youtube.com/8a5f55e3-99f3-...	a1.nyt.com	...	GET HTTPS	200	Yes	437.57 KB	0 B	311.1ms	19.79ms	149.2ms
tagx-simple.min.js	a248.e.akamai.net	...	GET HTTPS	200	Yes	32.56 KB	0 B	7.60s	24.03ms	0.154ms
sharetools-mixin.js	ad.doubleclick.net	...	GET HTTPS	200	No	42 B	559 B	18.93s	62.15ms	0.911ms
sharetools-config.js	ad.doubleclick.net	...	GET HTTPS	200	No	42 B	559 B	17.20s	244.0ms	0.839ms
showall.js	ad.doubleclick.net	...	GET HTTPS	200	No	42 B	559 B	5.23s	125.5ms	0.658ms
sharetools.js	ads.undertone.com	...	GET HTTPS	200	No	7 B	129 B	9.68s	1.09s	0.249ms
fonts.css	ag.innovid.com	...	GET HTTPS	200	No	43 B	288 B	9.69s	996.8ms	1.076ms
ad-view-manager.js	analytics.twitter.com	...	GET HTTPS	200	No	—	604 B	7.17s	1.14s	0.425ms
1.6.0.js	beacon.krxd.net	...	GET HTTPS	204	No	—	491 B	9.62s	2.13s	5.757ms

# Beyond Cookies

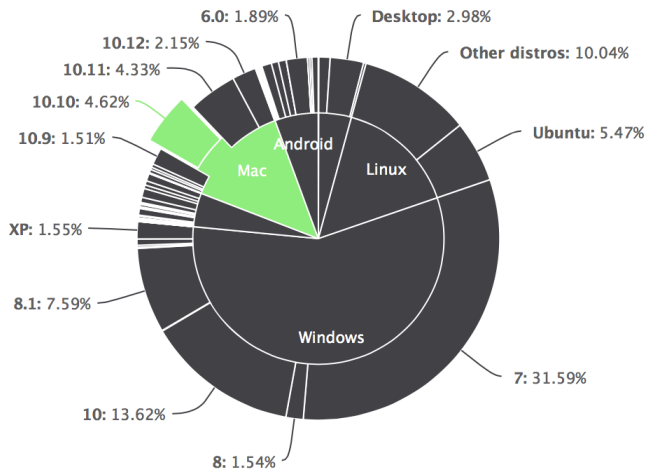
Zombie Cookies



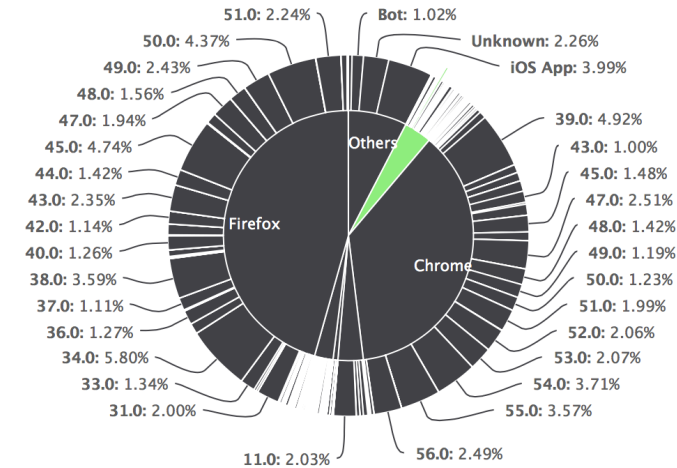
Browser Fingerprinting



# Fingerprinting Works



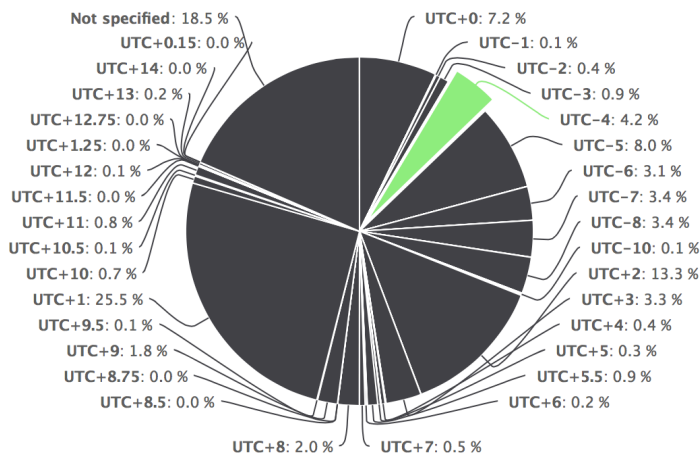
Operating System



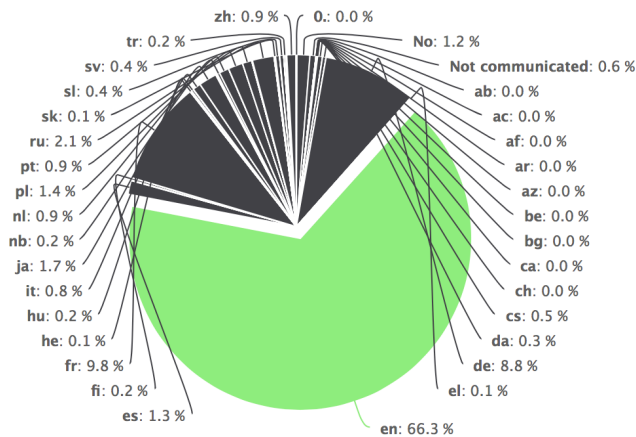
Browser

Cookies enabled ⓘ	77.92%	"yes"
Do Not Track ⓘ	30.91%	"yes"
Timezone ⓘ	4.23%	"240"
Screen resolution ⓘ	3.63%	"1280x800x24"
Use of local storage ⓘ	74.40%	"yes"
Use of session storage ⓘ	74.40%	"yes"

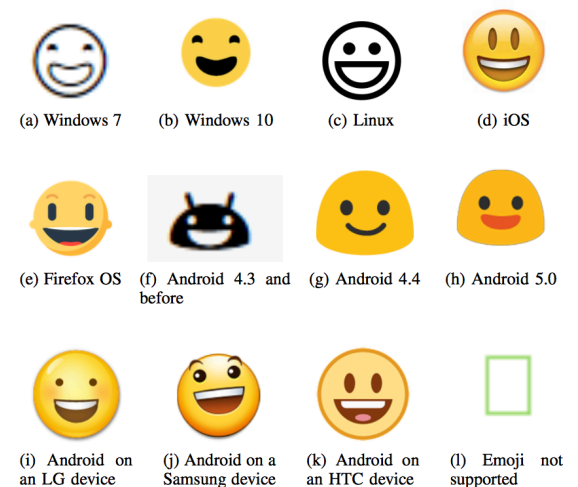
Settings



Time Zone



Language



Canvas

# The result...

## Your categories

Below you can review the interests and inferred demographics that Google has associated with your cookie. You can [remove](#) or [edit](#) these at any time.

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Business & Industrial

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Business & Industrial - Manufacturing

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Computers & Electronics - Computer Hardware - Laptops & Notebooks - Tablet PCs

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Computers & Electronics - Software - Multimedia Software - Photo & Video Software

---

Computers & Electronics - Software - Operating Systems - Mac OS

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Internet & Telecom - Mobile & Wireless - Mobile Phones

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Internet & Telecom - Mobile & Wireless - Mobile Phones - Smart Phones

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Online Communities - Social Networks

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Reference - General Reference - Time & Calendars

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Science - Mathematics



# Personalized Content



# Targeted Advertising



# Data Collection is Here to Stay...



*"Remember when, on the Internet, nobody knew who you were?"*